SUMMARY OF CURRENT PRE-CAMBRIAN NORTH AMERICAN LITERATURE.

MATTHEW[1] gives the following pre-Cambrian succession near St. John, N. B.:

A.—Laurentian.

1. *Portland group*, including Division 2, with probably parts of Division 1 in other localities than St. John.

2. *Intrusive granite* and quartz-diorite; perhaps later than the position here assigned to it.

B.—Huronian.

3. *Coldbrook group* or Div. 3, of volcanic rocks.

4. *Coastal group* or Div. 4, of volcanic and sedimentary rocks, in its upper part probably equivalent to the next group.

5. *Etcheminian or Basal Series*, of sedimentary rocks, underlying the St. John group.

6. *Kingston group* or Div. 5, of metamorphosed volcanics. Of very uncertian relations; may be post-Cambrian.

The Huronian in southern New Brunswick is in large part made up of surface volcanic rocks. The lower part or Coldbrook group is almost exclusively volcanic; the upper part or Etcheminian is clastic, while the intermediate Coastal contains both volcanic and sedimentary members. The effusive rocks include lavas, breccias, and tuffs, and with them may be placed a holocrystalline soda-granite which is probably either an intrusion or a very thick surface flow.

The Etcheminian series rests unconformably upon the Coldbrook series and unconformably below the St. John group, which is for this district placed at the base of the Cambrian. The igneous rocks comprise effusives, including quartz-porphyry, felsite-porphyry, diabase, and feldspar-porphyrites, and dike rocks, which include diorite-porphyrite, diabase, and augite porphyrite. Each of these is described in detail.

Bailey[2] gives a preliminary report upon southwestern Nova Scotia. The oldest rocks here found are those of the Cambrian system, in which there is the following succession from the base upward:

[1] The Effusive and Duke Rocks near St. John, N. B., by W. D. MATTHEW, Trans. N. Y. Acad. Sci., Vol. XIV., 1895, pp. 187–217, Plates XII.–XVII., Figs. A. B.

[2] Preliminary Report on Geological Investigations in Southwestern Nova Scotia,

1. Quartzite Division.
   (*a*) Heavily bedded blue quartzites, with slightly plumbaginous partings, alternating with numerous but much thinner beds of gray argillite. In metamorphic areas the quartzites become more micaceous, assuming the aspect of fine-grained gneisses, while the finer beds become glistening mica-schists.
   (*b*) Greenish-gray sandstones or quartzites, less massive than in (*a*) and alternating with slates which are arenaceous below, but become gradually more argillaceous above.
2. Slate Division.
   (*a*) Greenish-gray slates, becoming bluish or light gray, and passing into purple slates, or becoming clouded or zoned with shades of green, purple, blue, buff or pale yellow, often producing a conspicuous ribbanding of the beds. The occurrence of light yellowish-green seams is a characteristic feature of the purple slates.
   (*b*) Bluish-gray and blue slates, with lighter gray seams or bands, and including in places an upper zone of purple slates.
   (*c*) Black, with some blue or gray slates, often highly pyritiferous. In metamorphic regions the green slates are represented by chloritic and hornblendic schists (or locally by conglomerates with a micaceous or hornblendic base); the slaty beds by micaceous, garnetiferous, and andalusitic schists.

Above the Cambrian rocks are those belonging to the Devonian system. There are several important areas of granite, as follows: Those of South Mountains, Blue Mountains, Tusket Wedge, the Barrington area, Kelvin area, and Port Mouton area. These are intrusive within the Cambrian, and in places they clearly penetrate and alter the fossiliferous Devonian rocks.

Comments.—The rocks here referred to the Cambrian are the so-called gold-bearing slates. This great series I have regarded as probably equivalent to, and belonging in the same geological province with, slates of Newfoundland unconformably underlying the Cambrian. I have therefore doubtfully referred the Nova Scotia slates to the Algonkian. No palæontological evidence is given in this paper which decides between the Cambrian and Algonkian periods.

Bonney[1] states that the Eozoon of Côte St. Pierre is either a record of an organism, or a very peculiar and exceptional condition of a pyroxene-marble of Laurentian age, which is not a result of contact metamorphism in the ordinary sense of the term.

by L. W. BAILEY, Geol. Sur. of Can., Ann. Rep. for 1892–3 (new series), Report Q., 1895, pp. 21. With map.

[1] The Mode of Occurrence of Eozoon Canadense at Côte St. Pierre, by T. G. BONNEY, Geol. Mag., new ser., Vol. II., 1895, pp. 292–299.

Adams[1] describes a district of 3500 square miles of pre-Cambrian rocks belonging to the Grenville series immediately east of the original Laurentian area, described by Logan and Ells, and northwest of the city of Montreal. A subordinate part of the area about Trembling Mountain and another area to the west of St. Jerome are referred to the fundamental gneiss. The Grenville series occupies the major portion of the district, but about 1000 square miles is occupied by anorthosite, which occurs in one large area known as the Morin area, and ten smaller masses. The Morin anorthosite encloses detached masses of the gneiss. There are also present in the district one mass of intrusive syenite covering an area of thirty-six square miles, and a much larger one of granite in the northeast portion.

The Grenville series is composed of rocks in well-defined bands, the whole exhibiting a clear foliation, usually parallel to the banding. The series thus has a decidedly stratified appearance, similar to that presented by sedimentary rocks. The gneiss which on the west side of the area dips at an angle of 40°, toward the east become nearly flat, often quite so, and these nearly flat gneisses extend to the north and east far beyond the limits of the map. Throughout this area of flat-lying rocks, the gneisses with their interstratified limestones and quartzites are as highly crystalline as in the most highly contorted districts and have evidently undergone an extensive stretching or rolling out, resulting in the tearing apart of the less plastic bands with the flowing of the material of the more plastic bands into the spaces between the separated fragments.

Petrographically the rocks of the district are found to fall into four classes:

1. Anorthosites and granites of igneous origin. All gradations may be seen between the ordinary anorthosite and those in which the whole is granulated so as to resemble in appearance a saccharoidal marble. The whole rock thus moved under pressure like so much dough, its continuity being perfectly maintained. This is Professor Heim's "Umformung ohne Bruch," millions of little cracks taking the place of a few larger ones, and it is by this process that granites and many gneisses and other crystalline rocks when deeply buried under great pressure and probably very hot, move and accommodate themselves to stresses. This, it will be observed, is quite distinct and different from the shearing accompanied by the development of new materials, which takes place under other conditions and probably nearer the surface.

2. Augen-gneisses, leaf-gneisses, granulites, and foliated anorthosites, genetically connected with the last group, and largely, if not exclusively, of igneous origin also. The structural characteristic of this class is the cataclastic or granulated one, formed by the mechanical breaking down of the web of the rock under movements induced by great pressure, which movements produce in the rock a foliation more or less distinct, according to their intensity.

[1] A Further Contribution to our Knowledge of the Laurentian (Art. VII.), by F. D. ADAMS, Am. Journ. Sci. (3), Vol. L, 1895, pp. 58–69, with Plates I. and II.

3. A series of crystalline limestones and quartzites, together with certain gneisses usually found associated with them. In these rocks the granulated structure is very subordinate or entirely absent. They are characterized by a very extensive recrystallization with the development of new minerals. These minerals have crystallized under the influence of the pressure which granulated the gneisses of the second class, and are not in any marked manner deformed by it. These gneisses also differ from the granites and gneisses of classes 1 and 2 in chemical composition, giving analyses almost identical with those of slates. Moreover, the rocks of this class are very frequently graphitic, and analyses show that the gneisses correspond in chemical composition more closely with slates than with granites.

4. Pyroxene-gneisses, pyroxene-granulites, and allied rocks whose origin is as yet doubtful.

With regard to the Grenville series, from the presence of numerous and heavy beds of limestone and quartzite, their prevalent banded character, the widespread occurrence of graphite, and the fact that the gneisses associated with the limestones and quartzites have the composition of sands and muds and not of igneous rocks, it is concluded that it is extremely probable that this is an altered sedimentary series, which has been deeply buried, invaded by great masses of igneous rocks, and recrystallized. In places the Grenville sediments may have been mingled with the igneous rocks by actual fusion.

Smyth,[1] C. H. Jr., describes the crystalline limestones and associated rocks of the northwestern Adirondack region. The limestones, instead of being in limited patches as in the eastern part of the Adirondacks, are in extended belts many square miles in area. The limestone belt running through the townships of Rossie and Gouverneur has been traced more than twenty miles along the strike, while the average width is perhaps six miles. A narrower belt extends across Fowler into Edwards township. A third belt crosses the townships of Diana and Pitcairn, with an average width of two or three miles. In addition to these belts, numerous scattered patches have been noted in the western Adirondacks.

The limestones are highly crystalline, coarse, light gray or white rocks, containing silicates in separate crystals or segregated in lumps. Among these phlogopite, graphite, pyroxene, and tourmaline are most common. The limestone is usually so massive that it is difficult to ascertain the strike and dip with any accuracy. When observable, the strike is generally northeast and the dip northwest, though exceptions are common. Garnetiferous and micaceous gneisses and pyroxenic and hornblendic gneisses are intimately associated with the limestone. The former are in some cases distinctly inter-

[1] Crystalline Limestones and Associated Rocks of the Northwestern Adirondack Region, by C. H. SMYTH, Jr. Bull. Geol. Soc. of Am., Vol. VI., 1895, pp. 263–284.

bedded with the limestone, while many of the latter have the appearance of interbedded members, and others closely resemble somewhat modified intrusions. Wherever the hornblendic and pyroxenic gneisses appear, they show a great amount of crumpling and crushing, which goes from slight plication to elaborate contortion or to crushing into angular fragments in a paste of limestone, thus producing remarkable breccias. In all of these cases the limestone shows little or no sign of structural change, having the appearance of a plastic mass in which the contained layers could be twisted to any extent. It therefore follows that the massive and undisturbed appearance of the limestone, when free from gneissic layers, does not show that it has not been subjected to intense mechanical strain, as subsequent to this it may have recrystallized.

This limestone series has a marked resemblance to the Grenville series, but because it is difficult to establish such an equivalency, it is suggested that it be called the Oswegachie series. The areas between the belts of limestone are occupied by gneiss, whose origin and relations to the limestone series is doubtful. The limestone series can hardly be regarded as of other than sedimentary origin. In many cases these gneisses adjacent to the limestone closely resemble the interbedded garnetiferous gneisses, and doubtless should be regarded as members of the limestone series. These varieties pass gradually into more nearly massive gneisses of feldspathic aspect, and these are in a number of cases in direct contact with the limestone. A part of these gneisses at least are of igneous origin, as is shown by their contact relations, but whether this explanation is applicable to them all it is impossible to show. Intrusive in the limestone series are granite, diorite, gabbro, and diabase. Their intrusive nature is shown by all the usual phenomena characteristic of such relations.

The gabbro is most variable in its petrographical character. At one place it is in sharp contact with the granite. The relations of the gabbro to the gneiss are difficult to unravel. At Natural Bridge is found the normal gabbro, and in passing toward the red gneiss it appears to grade into it, and the two may be different facies of the same eruptive mass. The contact zones between the limestone and the intrusive gabbro are narrow and sharply defined, and this fact, combined with the great mechanical disturbances of the limestone series, justifies the conclusion that its metamorphism is largely dynamic.

Kemp[1] describes the crystalline limestones, ophicalcites and associated schists of the eastern Adirondacks. Study of the region seems to corroborate the conception of the Adirondack Mountains, as sketched by Van Hise, as a central intrusion of igneous rocks, with a fringing rim of older gneisses, schists, and limestones. A closer approximation would be to regard

[1] Crystalline Limestones, Ophicalcites and Associated Schists of the Eastern Adirondacks, by J. F. KEMP, Bull. Geol. Soc. Am., Vol. VI., 1895, pp. 241–262.

the intrusions as in several more or less parallel ranges, with remnants of the other rocks in the valleys between them and on the flanks is taken as a whole.

The limestones and the associated rocks always occur in depressions, the resistant ridges consisting of the harder gneiss or anorthosite. The former form sections as broad as 1000 feet, in which the limestone strata are, however, less than half, and the true thickness of which is difficult to determine because of the varying dips, schistosity, and possibility of faults. The white limestones are coarsely crystalline, usually graphitic, and often include silicates, from little scales to large bunches. At Keene Center, in the heart of the Adirondacks, is a white limestone and schist belt which contains magnetic iron ore, and is overlain by garnetiferous and pyroxenic schists, or pyroxenic granulite, the relations indicating that the latter is a gneissic rock interbedded with the limestone.

There is no marked break to be detected anywhere between the gneiss and the overlying limestone. Apparently the whole is a continuous series of strata, which are analogous in appearance with those of the Grenville series of Canada. It therefore does not appear certain that in the eastern Adirondack region are any rocks older than this series. The extent and persistence of the limestones and schists gives ground for believing that the series was a set of calcareous sediments and sandstones which have been metamorphosed and intruded by the anorthosites.

Kemp[1] describes the titaniferous iron ores of the Adironacks. These occur in the gabbros. The ores are regarded as segregations from the igneous magma formed during the process of cooling and crystallization.

Kemp and Marsters[2] give the field occurrence and microscopical characters of the trap dikes of the Lake Champlain region. The dikes are found to be bostonites, diabases, camptonites, fourchite, and monchiquite.

Sears[3] gives a description of each of the rocks of Essex county, Massachusetts. These comprise plutonic rocks, volcanic rocks, Archean rocks, and various metamorphosed sedimentary rocks of Palæozoic age.

Emerson[4] gives an outline of the geology of the Green Mountain region in Massachusetts. The Algonkian rocks comprise the Washington gneiss, Tyringham gneiss, East Lee gneiss, Hinsdale limestone, and Hinsdale gneiss.

[1] The Titaniferous Iron Ores of the Adirondacks, by J. F. KEMP, Abstract in Bull. Geol. Soc. Am., Vol. VII., 1895, p. 15.

[2] The Trap Dikes of the Lake Champlain Region, by J. F. KEMP and F. V. MARSTERS, Bull. 107, U. S. G. S. With map. Washington, 1893.

[3] Report on the Geology of Essex County, Massachusetts, to accompany map, by JOHN H. SEARS, Bull. Essex Inst., Vol. XXVI., 1894, pp. 118–139.

[4] Geol. Atlas of the U. S., Hawley Sheet, Preliminary Edition, by B. K. EMERSON. U. S. Geol. Sur. Washington, 1894,

This series is the equivalent of the Stamford gneiss in Hoosac Mountain. The Algonkian rocks consist of firm, coarse gneisses which contain minerals and possess structures not formed in the later rocks; thick beds of coarse and highly crystalline limestones which contain many minerals rarely found in later limestones, as chondrodite, wernerite, dark pyroxene and hornblende; and coarsely crystallized graphite; considerable beds of pyrrhotite, magnetite, and graphite also.

Because of the presence of the heavy beds of limestones, which were probably derived from shells and corals, we may assume that the whole series, except the hornblende-gneiss of East Lee, was of sedimentary origin, but we know nothing of the limits of the sea in which they were spread. These rocks are overlain by the Cambrian Becket gneiss and Cheshire quartzite. As shown by the basal conglomerate at the Dalton Club House, these rocks rest unconformably upon the Algonkian.

Emerson[1] describes the geology of Old Hampshire county in Massachusetts, which includes the present counties of Franklin, Hampshire, and Hampden. On the western border of the Green Mountain area, as it crosses Massachusetts and overlooking the Housatonic Valley, is a series of pre-Cambrian outcrops, which are the oldest rocks of the state and the substratum on which the others rest. They consist of coarse gneisses, especially characterized by blue quartz and allanite, coarse porphyritic structure and stretching; and by great beds of highly crystalline limestone, containing chondrodite, coccolite, titanite, phlogopite and wernerite.

The most important of these limestone beds are the Hoosac, the Hinsdale, and the Tyringham areas The limestone beds connected with the two latter have caused the two most important passes through the range—the Westfield Valley and the East Lee-Farmington Valley.

On the pre-Cambrian rocks rest the Becket conglomerate gneisses of Cambrian age, and above them a great series of sericite schists (the Hoosac schists, Rowe schists, Chester amphibolite and Hawley schists), which are about contemporaneous with the Stockridge limestone of the Housatonic Valley.

Dale[2] discusses the structure of the ridge between the Taconic and Green Mountain ranges in Vermont, and that of Monument Mountain in Great Barrington, Mass. He finds all the strata concerned to be Cambrian or post-Cambrian.

[1] Geology of Old Hampshire County, in Massachusetts, by B. K. EMERSON, Abstract in Bull. Geol. Soc. Am., Vol. VII., 1895, pp. 5–7.

[2] On the Structure of the Ridge between the Taconic and Green Mountain Ranges in Vermont, by T. NELSON DALE, Fourteenth Ann. Rep. U. S. G. S. (for 1892–3), Part II., 1894, pp. 525–549; and, The Structure of Monument Mountain in Great Barrington, Mass., *Ibid.*, p. 551–566.

Collie[1] describes the geology of Conanicut Island, R. I. The oldest rocks are a series of slates of unknown age, into which was intruded a mass of granite, porphyritic in character. This complex was exposed to weathering influences until a bed of débris lay upon its surface. This surface was depressed beneath the sea, and upon it was laid a great series of carboniferous rocks. The complex was, therefore, the Carboniferous shore line. Into the Carboniferous rocks dikes were intruded, and both were folded, metamorphosed, and have in many places become schistose.

Wolff[2] reaches the following conclusions as a result of his detailed study of the Highlands of New Jersey in the vicinity of Hibernia. The rocks are found to consist of distinct bands of gneiss which can be recognized. These layers have once been nearly horizontal, and are folded into an anticlinal dome which has the characteristics of ordinary folds, and has a distinctly recognizable pitch. The rocks of the series have a top and bottom, the latter being at the center of the dome and the top ones at the periphery. One characteristic horizon, a garnet-biotite-graphite-gneiss, must once have existed over a large part of the present area, and the same is probably true of the lower horizons. The foliation, in part at least, is parallel to the bounding planes of the different layers of rocks. The crystallization of the rock occurred during or after the action of the compressing force which folded the rocks and produced pitch but not before, since this structure is inherent in the shape of the minerals as they crystallized. These facts favor the view that the series is a sedimentary one, in which metamorphism and recrystallization took place contemporaneously with the folding and without fusion, and therefore that it is of Algonkian age.

Keith[3] gives the geology of the Catoctin belt. The pre-Cambrian rocks constituting the Blue Ridge core are all of igneous origin. They include quartz-porphyry and andesite, Catoctin schist, and granite. A detailed lithological description is given of each of these rocks and of their alterations. The Catoctin schist and the granite are separated by areas in which the two are intimately intermingled. The Catoctin schist is an altered diabase, and the diabase is believed to be separable into two flows with a time gap between them. An evidence of this is a discordance of structure. The order of the events was probably as follows: (1) Diabase extrusion, (2) granite intrusion, (3) erosion interval, (4) quartz-porphyry and andesite flows, (5) erosion inter-

[1] The Geology of Conanicut Island, R. I., by G. L. COLLIE, Trans. Wis. Acad. Sci., Arts and Letters, Vol. X., 1894–5, pp. 199–230, with Pl. IV.

[2] Geological Structure in the vicinity of Hibernia, N. J., by J. E. WOLFF, Geol. Sur. of N. J., Ann. Rep. for 1893, pp. 359–369, 1895.

[3] The Geology of the Catoctin Belt. by ARTHUR KEITH, Fourteenth Ann. Rep. U. S. G. S. (for 1892–3), Part II., pp. 285–395; and Geol. Atlas of the U. S., Harper's Ferry Folio. U. S. G. S. Washington, 1894.

val (?), (6) diabase flow, and (7) erosion interval. The different lavas have been folded, faulted, and secondary structures have developed within them. Metamorphism was most extensive in the diabase, which has become a well-developed schist. The quartz-porphyry is the least altered.

Merrill [1] describes the disintegration of the granite rocks in the District of Columbia, and finds from chemical analyses, calculated on a water-free basis, that they are very similar to those of the original rocks, and therefore that the rocks are as much disintegrated as decomposed. The chief chemical change is hydration.

Haworth [2] maps and fully describes many areas of pre-Cambrian crystalline rocks of Missouri. These occur in irregular areas and isolated hills extending over an area seventy miles square in the southeastern part of the state. The rocks consist of granites, granophyres, and porphyries, which are occasionally cut by diabase dikes. Some of the granophyres are located between the granite and the porphyry areas, and seem to be a connecting link between them. At other times they are in contact only with the granite or with the porphyry, in which case the connections are traceable in one direction only. It is concluded that all are different facies of a magma belonging to a single period of igneous activity. Associated with the pre-Cambrian are clastic beds occupying small areas, as for example, at the summit of Pilot Knob.

Hill [3] finds in Indian Territory in the heart of the area occupied by the Chickasaw Nation, a granite called the Tishomingo granite, which appears to be of pre-Palæozoic age.

Russell [4] finds as a result of a geological reconnoissance in central Washington that in Okanogan county there are granites, schists, quartzites, and allied rocks. Resting upon the upturned and eroded edges of these crystalline rocks is the Kittitas series, which belongs to the Tertiary system.

Iddings, Weed, and Hague [5] describe and map the geology of the Livington sheet, Montana. Archean crystalline rocks constitute a part of the southern half of the region. These include mica-schists, phyllite, gneiss, and granite. Much of the granite is eruptive and carries angular blocks of other

[1] Disintegration of the Granitic Rocks of the District of Columbia, by GEORGE P. MERRILL, Bull. Geol. Soc. Am., Vol. VI., 1895, pp. 321–332, Pl. XVI.

[2] The Crystalline Rocks of Missouri, by ERASMUS HAWORTH, Missouri Geol. Sur., Vol. VIII., 1895, pp. 84–222 with map and plates.

[3] Notes on a Reconnoissance of the Ouachita Mountain System in Indian Territory, by R. T. HILL, Am. Jour. Sci. (III.) Vol. XLII., 1891, pp. 11–124.

[4] A Geological Reconnoissance in Central Washington, by I. C. RUSSELL, Bull. 108, U. S. G. S., p. 20, with map. Washington, 1893.

[5] Geol. Atlas of the U. S., Livingston, Folio No. 1, by J. P. IDDINGS, WALTER H. WEED, and ARNOLD HAGUE, U. S. Geol. Sur. Washington, 1894.

rocks. The foregoing are cut by veins and dikes of crystalline rocks, both basic and acid. Resting unconformably upon the Archean rocks is the Belt formation, which is supposed to belong to the Algonkian period. This formation is found on the western flank of the Bridger range. The rocks comprise sandstones, conglomerates, slates, and arenaceous limestones. The series is about 2500 feet thick within the area mapped. The Algonkian rocks are overlain conformably by the Cambrian Flathead quartzite.

Eldridge,[1] from a geological reconnoissance in northwest Wyoming, finds that Archean granites, gneisses, and schists of various types form the crest of the Big Horn, Wind River, Absaroka, and Owl-Rattlesnake ranges. In the Wind River and Absaroka ranges the Archean areas are extensive. Resting upon the Archean rocks and in many places deriving material from them, are the rocks of the Cambrian system.

Cross[2] describes and maps the geology of the Pike's Peak sheet. The oldest rocks here found are Algonkian quartzites and allied rocks, which occur as fragments included in the granite. These vary in size from that shown in Wilson park to minor fragments. The Wilson park mass is nearly 4000 feet in thickness, stands on end, and is exposed along the strike for about five miles. Other important masses of quartzite are in Cooper Mountain and Blue Mountain. These masses are cut by minute dikes and are entirely surrounded by granite. Smaller fragments are very numerous. Associated with the quartzites are certain gneisses and schists which almost grade into the quartzites, and probably represent metamorphosed Algonkian strata. Schists also occur, especially in the Cripple Creek district, and these seem to represent earthy metamorphosed Algonkian rocks. Granites and gneissoid granites occupy much the larger part of the Pike's Peak sheet. The more important granites are the coarse-grained Pike's Peak type and a fine-grained granite. The gneissoid granites are but foliated phases of the granites, and between the two there are gradations. All the granites are cut by coarse granitic dikes and veins. The Silurian rocks rest unconformably upon, and derived fragments from, all the previous formations.

Eldridge[3] maps and describes the Crested Butte sheet, Colorado, and finds that on the northwest and southeast corners of the district are Archean areas. These consists mainly of granite and granite-gneiss, with local developments of gneiss and schist.

[1] A Geological Reconnoissance in Northwest Wyoming, by GEORGE H. ELDRIDGE, Bull. 119, U. S. G. S., p. 17, with Geol. Map. Washington, 1894.

[2] Geol. Atlas of the U. S., Pike's Peak Folio, No. 7, by WILLIAM CROSS, U. S. Geol. Sur. Washington, 1894.

[3] Geol. Atlas of the U. S., Anthracite-Crested Butte, Folio No. 9, by GEORGE H. ELDRIDGE, U. S. Geol. Sur. Washington, 1894.

Walcott[1] gives the results of his study of the Algonkian rocks of the Grand Canyon of the Colorado. The following classification of the rocks is adopted :

Cambrian	Tonto	
——Unconformity——		
Algonkian	Grand Canyon	Chuar Unkar
——Great Unconformity——		
Algonkian (?)	Vishnu.	

The Vishnu at the one point examined, due south of Vishnu's Temple, consists of micaceous schists and quartzites, cut by dikes and veins of granite. The Unkar terrane, 6830 feet thick, consists of limestones, sandstones, conglomerates, and intrusive and extrusive basic rocks of various kinds. The basal conglomerate is formed largely of pebbles derived from the upturned edges of the pre-Unkar strata. The Chuar terrane, 5120 feet thick, consists mainly of shales of various kinds, but contains 285 feet of limestone. Resting unconformably upon the Grand Canyon series is the Tonto Cambrian. Before the deposition of the latter the Grand Canyon series was planed to a base level, and all the strata of the series were truncated.

Midway in the lower portion of the shales and limestones of the Chuar terrane the presence of fauna is shown by a minute discinoid or patelloid shell, a small Lingula-like shell (which may be a species of Hyolithes), and a fragment of what appears to be the pleural lobe of a segment of a trilobite belonging to a genus allied to the genus Olenellus, Olenoides or Paradoxides. There is also a Stromatopora-like form that is probably organic.

The entire Grand Canyon series is placed in the Algonkian period or Proterozoic era. Various possible correlations of the Grand Canyon with other series may be made, but it is evident that until characteristic fossils are found in the various terranes now referred to the Algonkian, it will be impossible to make any correlations that will be more than tentative suggestions.

Sapper,[2] in 1894, describes and maps considerable areas of Azoic formations in Guatemala. The lowest formations are gneiss and the higher formations are mica-schists and phyllites, associated with which are crystalline limestones, actinolite-schistt, and quartzites. Closely associated with these schistose rocks are ancient eruptive rocks, including granite, diabase, etc. Whether these Azoic formations are pre-Palæozoic or not cannot as yet be asserted.

[1] Algonkian Rocks of the Grand Canyon of the Colorado, by C. D WALCOTT, JOUR. OF GEOL., Vol III., April–May 1895, pp. 312–330, and 14th Ann Rep. U. S. G. S. (for 1892–3), Part II., pp. 487–524.

[2] Grundzüge der physikalischen Geographie von Guatemala, by CARL SAPPER, J. Perthes' Geog. Anst., Ergänzungsheft, Nr. 113, 1894, pp. 59, with 4 maps.